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Inside this issue: One Health

The concept of One Health is based on the recognition that there are interconnections among human, animal and environmental health and there is increasingly a need to cross professional, disciplinary and institutional boundaries to address these. This issue highlights the fact that tropical diseases may only be an airplane ride away, that recreational waters can be affected by environmental factors that may be amenable to satellite surveillance and that severe weather (e.g. typhoons) can disrupt public health activities (e.g. immunization).

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One Health, Public Health Agency of Canada
http://www.phac-aspc.gc.ca/owoh-umus/index-eng.php

Ebola Clinical Care Guidelines: A Guide for Clinicians in Canada. Canadian Critical Care Society, Canadian Association of Emergency Physicians, Association of Medical Microbiology and Infectious Diseases Canada.
http://cccsnew.businesscatalyst.com/website/Articles%20Reports/Ebola%20Clinical%20Care%20Guidelines-2014-8-28a.pdf

Visit Fightful.ca for the latest information on seasonal influenza
http://www.fightflu.ca/index-eng.php

Upcoming conferences

Nov 13-15, 2014: Family Medicine Forum, Quebec City, Quebec. College of Family Physicians of Canada
http://fmf.cfpc.ca/

October 8-12, 2014: Infectious Disease Week, Philadelphia, Pennsylvania. Infectious Disease Society of America.
http://idsociety.org/meetings.aspx

Travel-acquired infections in Canada: CanTravNet 2011—2012

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Abstract

Background: Important gaps remain in our knowledge of the infectious diseases people acquire while travelling and the impact of pathogens imported by Canadian travellers.

Objective: To provide a surveillance update of illness in a cohort of returned Canadian travellers and new immigrants.

Methods: Data on returning Canadian travellers and new immigrants presenting to a CanTravNet site between September 2011 and September 2012 were extracted and analyzed by destination, presenting symptoms, common and emerging infectious diseases and disease severity.

Results: During the study period, 2283 travellers and immigrants presented to a CanTravNet site, 88% (N=2004) of whom were assigned a travel-related diagnosis. Top three destinations for non-immigrant travellers were India (N=132), Mexico (N=103) and Cuba (N=89). Fifty-one cases of malaria were imported by ill returned travellers during the study period, 60% (N=30) of which were Plasmodium falciparum infections. Individuals travelling to visit friends and relatives accounted for 83% of enteric fever cases (15/18) and 41% of malaria cases (21/51). The requirement for inpatient management was over-represented among those with malaria compared to those without malaria (25% versus 2.8%; $p<0.0001$) and those travelling to visit friends and relatives versus those travelling for other reasons (12.1% versus 2.4%; $p<0.0001$). Nine new cases of HIV were diagnosed among the cohort, as well as one case of acute hepatitis B. Emerging infections among travellers included hepatitis E virus (N=6), chikungunya fever (N=4) and cutaneous leishmaniasis (N=16). Common chief complaints included gastrointestinal (N=804), dermatologic (N=440) and fever (N=287). Common specific causes of chief complaint of fever in the cohort were malaria (N=47/51 total cases), dengue fever (14/18 total cases), enteric fever (14/17 total cases) and influenza and influenza-like illness (15/21 total cases). Animal bites were the tenth most common diagnosis among tourist travellers.

Interpretation: Our analysis of surveillance data on ill returned Canadian travellers provides a recent update to the spectrum of imported illness among travelling Canadians. Preventable travel-acquired illnesses and injuries in the cohort include malaria, enteric fever, HIV, hepatitis B, hepatitis A, influenza and animal bites. Strategies to improve uptake of preventive interventions such as malaria chemoprophylaxis, immunizations and arthropod/animal avoidance may be warranted.

Introduction

In 2012, Canadians spent $36.5 billion on international tourism, up from $35.9 billion the year before (1). Top tourist destinations for Canadians continue to include tropical and economically developing countries such as Mexico, Cuba, the Dominican Republic and Jamaica (2). In 2012, of the 11,363,100 Canadians who stayed one or more nights at a destination other than the United States, almost a third travelled to one of those four countries.

International tropical travel puts travellers at risk of enteric and vector-borne infectious diseases (3-5), many of which are preventable through specific interventions such as chemoprophylaxis, immunization, insect repellents, personal protective measures and avoidance (4). A large-scale analysis of illness in returned Canadian travellers and new immigrants over a two-year period has recently been published by members of CanTravNet (6), provides Canadian practitioners with an epidemiologic roadmap of travel-acquired infections, which can be used to inform decision-making in both the pre-travel and post-travel setting.

This surveillance report provides an update to the two-years' worth of CanTravNet data published previously (6) and highlights the breadth of illnesses encountered by Canadians visiting >130 countries over a one-year period and presenting for care at a CanTravNet site.

Methods

Data sources

Six Canadian sites from four provinces (British Columbia, Alberta, Ontario and Quebec) also belonging to the GeoSentinel Global Surveillance Network have grouped together to form the core sites of CanTravNet (6). The six sites in Canada are large referral-based outpatient centres that primarily service the Greater Vancouver/Victoria, Calgary, Toronto, Ottawa and Montreal areas, which account for 47% of the Canadian population (or, a catchment of ~15.5 million people). They are staffed by specialists in travel and tropical medicine and immediate referral from the affiliated emergency departments is common.

Data were collected using the GeoSentinel data platform. This network is comprised of 56 specialized travel/tropical medicine clinics on six continents, which contribute denominalized clinician- and questionnaire-based travel surveillance data on all ill travellers examined to a centralized Structured Query Language database (7). (For additional details see http://www.istm.org/geosentinel). Collected data include patient demographics, details of recent travel, five-year travel history, purpose of travel and presence of absence of a pre-travel encounter with a healthcare provider. Final diagnoses are made by attending physicians and assigned a diagnostic code selected from a standardized list of >500 diagnostic entities, including etiologic (e.g. Giardia) and syndromic (e.g. cough) diagnoses. Syndromic codes are entered where an etiologic code cannot be assigned due to use of empiric therapy, self-limited disease, or inability to justify a more extensive workup as part of routine clinical practice. All CanTravNet sites contribute microbiologically confirmed data, where available, based on the best national reference diagnostic tests (including molecular diagnostics) available at the time. 'Probable' diagnoses are restricted to patients with pathognomonic physical findings (e.g. tick eschar), clinical response to highly specific therapy, or classical presentation and exposure history with laboratory exclusion of other possible etiologies (6). Further details regarding CanTravNet can be found at http://www.istm.org/cantravnet.

Definitions and classifications

Reason for most recent travel. Six possible travel purpose designations are available: immigration (including refugee), tourism, business, missionary/volunteer research/aid work, visiting friends and relatives, and "other" (students, military personnel and medical tourists). A visiting friends and relatives (VFR) traveller is defined as an immigrant who is ethnically and/or racially distinct from the majority population in their current country of residence and who returns to his homeland to "visit friends and relatives". VFR travellers also include children of foreign-born parents (e.g. second generation immigrants) who return to their parent's homeland to visit friends and relatives. A VFR traveller designation is typically applied to individuals travelling from a high-income country of current residence to a low-income country of origin (8). "Medical tourists" are defined as those for whom the primary purpose of travel is to seek health care, and as a consequence of travel, acquire an infectious complication secondary to the medical care received or become ill with an infectious or non-infectious disease while abroad.

Countries of exposure and travel were assigned 14 regional classifications: North America, Central America, the Caribbean, South America, Western Europe, Eastern Europe, the Middle East, North Africa, Sub-Saharan Africa, South Central Asia, Southeast Asia, Northeast Asia, Australia/New Zealand and Oceania.

Inclusion criteria

Demographic, clinical and travel-related data on Canadian citizens and new immigrants to Canada encountered after completion of their international travel or residence abroad and seen in any of five CanTravNet sites from September 2011 to September 2012 were extracted and analyzed. (The Calgary site was new to GeoSentinel as of 2012 and did not contribute cases during the study period.) Only patients with probable or confirmed final diagnoses (specific etiology or syndrome as described previously (6)) were included.

Descriptive analysis

Extracted data were managed in a Microsoft Access database and analyzed using standard parametric and non-parametric techniques. Travellers were described by purpose of travel, demographics, diagnoses, country of exposure and region of travel. Top syndromic and etiologic diagnoses were described for each purpose of travel. Top chief complaints were described by represented causative diagnoses and top source countries. Comparisons between categorical variables (e.g. purpose of travel) were made using Yates' corrected chi-square analysis, while continuous variables (e.g. age) were analyzed for significant differences using the Student's t-test and in the case of non-normally distributed parameters, the Mann-Whitney Rank Sum test. For a particular variable (e.g. purpose of travel or diagnosis), the reference population was all other travellers in the cohort without that variable (e.g. malaria versus non-malaria). Differences between groups of continuous variables were compared using One Way ANOVA or Kruskal Wallis One Way ANOVA on ranks. All statistical computations were performed using SigmaStat 2.03 software (SPSS Inc., Chicago, IL). Level of significance was set at $p<0.05$.

Results

Patients and demographics

For the surveillance period reported, the cohort of 2283 travellers who presented to a CanTravNet site was assigned 2377 confirmed and 338 probable diagnoses. Of the 2283 travellers seen, 2004 (87.8%) had a travel-related diagnosis (hereafter referred to as "ill returned travellers"), 166 (7.3%) had a non-travel-related diagnosis and 113 (4.9%) had a diagnosis whose relatedness to travel could not be ascertained. The cohort of 2283 travellers presented to one of five CanTravNet sites as follows: Montreal-McGill (N=955, 41.8%), Toronto (N=521, 22.8%), Ottawa (N=451, 19.8%), Montreal-Centre Hospitalier de l'Université de Montreal (CHUM) (N=245, 10.7%)

and Vancouver/Victoria (N=111, 4.9%). Major demographic variables for the cohort of 2004 travellers with travel-related diagnoses are summarized in **Table 1**. Top countries of birth for individuals born outside of Canada (N=915) were: India (N=82, 9%), China (N=42, 4.6%), Philippines (N=41, 4.5%), France (N=38, 4.2%) and the United States (N=32, 3.5%), with 129 represented countries.

Non-immigration travellers in the cohort (i.e. all travellers in the cohort except those travelling for the purpose of immigration) (N=1511/2004) for whom exposure country was known (N=1349) visited 133 different countries, the most frequently visited of which included: India (N=132, 9.8%), Mexico (N=103, 7.6%), Cuba (N=89, 6.6%), Dominican Republic (N=71, 5.3%) and Thailand (N=49, 3.6%).

Table 1: Demographic and clinical characteristics of 2004 returned travellers or new immigrants presenting to a CanTravNet site for care of a travel-related illness, 2011–2012*

Characteristic	All travellers n = 2004		Purpose of travel; no. (%) of travellers‡											
			Tourism n = 883		Immigration n = 493		Visit friends and relatives n = 206		Missionary, volunteer, researcher, aid worker n = 212		Business n = 160		Other§ n = 50	
Sex														
Male	856	42.7	327	37.0	240	48.7	101	49.0	73	34.4.	97	60.6	18	36.0
Female	1147	57.2	556	63.0	252	51.1	105	51.0	139	65.6	63	39.4	32	64.0
Unknown	1				1	0.2								
Age, yr, median (range)	38	0 - 87	38	1 - 81	39	1 - 84	40	0 - 87	30	15 - 79	41	22 - 78	25	9 - 70
Type of patient														
Inpatient	68	3.4	13	1.5	20	4.1	25	12.1	4	1.9	5	3.1	1	2.0
Outpatient	1936	96.6	870	98.5	473		181		208		155		49	
Travel duration, d, median (range)	20	0 - 3660	15	0 - 3660	NA	NA	36	1 - 553	37	3 - 3659	21.5	1 - 1339	46	3 - 2526
Pre-travel medical encounter														
Yes	594	29.6	299	33.9	NA	NA	33	16.0	143	67.5	83	51.9	29	58.0
No	656	32.7	362	41.0	NA	NA	116	56.3	24	11.3	40	25.0	14	28.0
Unknown	754	37.6	222	25.1	NA	NA	57	27.7	45	21.2	37	23.1	7	14.0
Syndromic diagnoses														
Gastrointestinal	986	49.2	456	51.6	200	40.6	91	44.2	114	53.8	93	58.1	32	64.0
Dermatologic	434	21.7	311	35.2	15	3.0	35	17.0	37	16.0	25	15.6	11	22.0
Systemic febrile illness	225	11.2	70	7.9	36	7.3	60	29.1	28	13.2	28	17.5	3	6.0
Respiratory	113	5.6	41	4.6	35	7.1	15	7.3	9	4.2	12	7.5	1	2.0
Geographic region of exposure														
Sub-Saharan Africa	444	22.2	76	8.6	141	28.6	58	28.2	105	49.5	52	32.5	22	44.0
Caribbean	304	15.2	245	27.7	32	6.5	14	6.8	25	11.8	13	8.1	1	2.0
South Central Asia	278	13.9	73	8.3	104	21.1	71	34.5	13	6.1	11	6.9	9	18.0
Central America	214	10.7	182	20.6	4	0.8	11	5.3	15	7.1	16	10.0	7	14.0
South East Asia	206	10.3	112	12.7	69	14.0	10	4.9	9	4.2	11	6.9	0	0
South America	123	6.1	58	6.6	14	2.8	20	9.7	14	6.6	13	8.1	6	12.0
North East Asia	74	3.7	16	1.8	44	8.9	7	3.4	1	0.5	8	5.0	1	2.0
North America	51	2.5	42	4.8	1	0.	0	0	1	0.5	6	3.8	1	2.0

Western Europe	34	1.7	24	2.7	7	1.4	1	0.5	1	0.5	1	0.6	0	0
Eastern Europe	38	1.9	3	0.3	27	5.5	6	2.9	1	0.5	0	0	1	2.0
Middle East	36	1.8	8	0.9	21	4.3	2	1.0	0	0	5	3.1	0	0
North Africa	41	2.0	10	1.1	19	3.9	4	1.9	4	1.9	6	3.8	0	0
Australia / New Zealand	5	0.2	3	0.3	0	0	0	0	0	0	1	0.6	1	2.0
Oceania	8	0.4	4	0.5	2	0.4	0	0	2	0.9	0	0	0	0
Unknown	148	7.4	99	11.2	8	1.6	2	1.0	21	9.9	17	10.6	1	2.0
Birth country														
Canada	1089	54.3	732	82.9	0	0	42	20.4	161	75.9	117	73.1	36	72.0
Outside Canada	915	45.7	151	17.1	493	100.0	164	79.6[†]	51	24.1	43	26.9	14	28.0

*The cohort consisted of 2004 travellers with a definitive travel-related diagnosis,166 with a non-travel–related diagnosis and 113 with a diagnosis for which relation to travel could not be ascertained. This analysis includes only those travellers with a travel-related diagnosis.

‡Except where indicated otherwise.

§Includes students (n = 42), military personnel (n = 6) and medical tourists (n = 2).

†Among those born outside of Canada, people who travelled for the purpose of visiting friends and relatives were defined as immigrants who were ethnically and/or racially distinct from the majority population in their current country of residence and who returned to their homeland to visit friends and relatives. This group also included children of foreign-born parents (e.g. second generation immigrants) who returned to their parents' homeland to visit friends and relatives.

Diagnoses

A total of 2402 travel-related diagnoses were issued to 2004 ill returned travellers. Of these diagnoses, 2078 were confirmed and 324 were probable. The most frequently issued travel-related diagnoses in persons travelling for the purpose of immigration were: latent tuberculosis, chronic hepatitis B, active tuberculosis, chronic hepatitis C and strongyloidiasis (**Table 2**). The most frequently issued travel-related diagnoses among non-immigration travellers were: post-infectious irritable bowel syndrome, acute diarrhea, chronic diarrhea, skin and soft tissue infections and arthropod bites (**Table 2**). **Table 3** lists the top travel-related diagnoses and countries of exposure for travellers presenting with a chief complaint of fever, gastrointestinal symptoms and skin disease. **Table 4** describes cases of malaria among the 2004 ill returned travellers.

Table 2: Top 10 syndromic and etiologic diagnoses by reason for travel among 2004 ill returned travellers with definitive travel-related diagnoses, 2011–2012

		Travellers with travel-related diagnosis unrelated to immigration; no. (%) of travellers					
Rank	**Immigrants with travel-related diagnosis n = 493**	**All non-immigration travellers n = 1511**	**Tourism n = 883**	**Visiting friends and relatives n = 206**	**Missionary, volunteer, researcher, aid worker n = 212**	**Business n = 160**	**Other* n = 50**
Total no. of travel-related diagnoses	583	1819	1062	250	257	195	55
1	Latent TB 173 (35.1)	PI-IBS 132 (8.7)	Acute diarrhea† 110 (12.5)	Malaria 21 (10.2) (*P. falciparum* 12 (5.8))	Chronic diarrhea 24 (11.3)	Acute diarrhea† 19 (11.9)	SSTI‡ 7 (14.0)
2	Chronic HBV 90 (18.3)	Acute diarrhea† 132 (8.7)	PI-IBS 87 (9.9)	Enteric fever‡ 15 (7.3)	PI-IBS 18 (8.5)	PI-IBS 16 (10.0)	Chronic diarrhea 6 (12.0)
3	Active TB 50 (10.1) (pulmonary TB 29 (5.9))	Chronic diarrhea 119 (7.9)	Chronic diarrhea 70 (7.9)	Acute diarrhea† 13 (6.3)	Acute diarrhea† 17 (8.0)	Chronic diarrhea 10 (6.3)	PI-IBS 5 (10.0)

4	Chronic HCV 33 (6.7)	SSTI‡ 83 (5.5)	Arthropod bite 65 (7.4)	Chronic diarrhea 9 (4.4)	SSTI‡ 13 (6.1)	Viral syndrome 10 (6.3)	Acute diarrhea† 5 (10.0)
5	Strongyloidiasis 25 (5.1)	Arthropod bite 79 (5.2)	Rash 52 (5.9)	Febrile illness < 3 wk duration 7 (3.4)	Malaria 12 (5.7) (*P. falciparum* 9 (4.2))	Malaria 9 (5.6) (*P. falciparum* 5 (3.1))	Giardiasis 4 (8.0)
6	Filariasis 22 (4.5)	Rash 74 (4.9)	SSTI‡ 50 (5.7)	Rash 7 (3.4)	Abdominal pain / dyspepsia 12 (5.7)	Rash 7 (4.4)	Latent TB 3 (6.0)
7	Hydatid 17 (3.4)	Abdominal pain / dyspepsia 62 (4.1)	Cutaneous larva migrans 40 (4.5)	PI-IBS 6 (2.9)	Latent TB 11 (5.2)	Blastocystis 7 (4.4)	Abdominal pain / dyspepsia 3 (6.0)
8	Schistosomiasis 17 (3.4)	Giardiasis 47 (3.1)	Abdominal pain / dyspepsia 39 (4.4)	SSTI‡ 5 (2.4)	Febrile illness < 3 wk duration 8 (3.8)	Giardiasis 6 (3.8)	Blastocystis 2 (4.0)
9	HIV 12 (2.4)	Malaria 45 (3.0) (*P. falciparum* 29 (1.9))	Giardiasis 28 (3.2)	Viral syndrome 5 (2.4)	Blastocystis 8 (3.8)	Febrile illness < 3 wk duration 5 (3.1)	Schistosomiasis 2 (4.0)
10	Leprosy 10 (2.0)	Blastocystis 45 (3.0)	Animal bite§ 23 (2.6)	Blastocystis 5 (2.4)	Giardiasis 6 (2.8)	Dientamoebiasis 4 (2.5)	Rash 2 (4.0)

HBV = hepatitis B virus, HCV = hepatitis C virus, P. falciparum = Plasmodium falciparum, PI-IBS = post-infectious irritable bowel syndrome, SSTI = skin and soft tissue infection, TB = tuberculosis, URTI = upper respiratory tract infection.

*Includes students (n = 42), military personnel (n = 6) and medical tourists (n = 2).

†Includes acute bacterial, parasitic and viral diarrhea, as well as acute diarrhea of unspecified etiology.

‡Includes erysipelas, cellulitis, furunculosis, carbuncles, skin abscess, pyoderma, ecthyma, impetigo and superficial fungal skin infections.

§Includes bites by cats, dogs, monkeys and other animals and monkey scratches.

¶Includes infection with Salmonella enterica serotype Typhi or Paratyphi or Typhoid fever unspecified.

Table 3: Top diagnoses and source countries for specific etiologies within syndromic chief complaints among 2004 ill returned travellers with definitive travel-related diagnoses

Diagnosis	No. (%) of patients*		Total no. in database (travel-related)	Top three£ source countries for diagnosis
Chief complaint fever (n = 287)				
Malaria	47	92.2	51	India, Nigeria, Sierra Leone
Plasmodium falciparum	28	93.3	30	Nigeria, Haiti
Severe cerebral	1	100.0	1	
Plasmodium vivax	11	91.7	12	India, Pakistan, Afghanistan
Plasmodium species unknown	6	100.0	6	
Plasmodium ovale	1	50.0	2	Nigeria, South Sudan
Dengue fever	14	77.8	18	Vietnam, Thailand, Guyana
Active tuberculosis	17	29.8	57	India, Philippines, China, Vietnam
Pulmonary	7	20.6	34	
Extrapulmonary	10	43.5	23	

Enteric fever	14	82.4	17	India, Pakistan
Salmonella enterica serotype Typhi	7	77.8	9	
Salmonella enterica serotype Paratyphi	4	100.0	4	
Typhoid fever, unspecified	3	75.0	4	
Influenza / Influenza-like illness	15	71.4	21	Peru, India, Dominican Republic
Upper respiratory tract infection	9	45.0	20	India, Dominican Republic
Pneumonia	9	56.3	16	China, Thailand
Lobar	7	53.8	13	
Atypical	2	66.7	3	
Acute urinary tract infection	5	50.0	10	India
Rickettsioses, spotted fever†	7	87.5	8	South Africa, India, Malawi, Namibia
Chikungunya fever	2	50.0	4	India, Pakistan, Cambodia, Kenya
Brucellosis	1	33.3	3	Dominican Republic, Iraq, Peru
Chief complaint gastrointestinal (n=804)				
Acute diarrhea‡	128	96.2	133	Mexico, India, Dominican Republic
Post-infectious irritable bowel syndrome	133	100.0	133	India, Cuba, Mexico
Chronic diarrhea	122	99.2	123	Cuba, India, Mexico
Giardiasis	42	87.5	48	India, Cambodia, Ghana
Dientamoebiasis	27	90.0	30	Mexico, Dominican Republic
Campylobacteriosis	16	100.0	16	Peru, Indonesia, India, Cambodia
Cryptosporidiosis, cyclosporiasis	8	80.0	10	United States, Costa Rica
Amoebiasis due to *Entamoeba histolytica*§	4	100.0	4	Dominican Republic, India, Turkey
Chief complaint dermatologic (n =440)				
Skin and soft tissue infection**	60	72.3	83	Cuba, India, United States
Arthropod bite	77	97.5	79	United States, Dominican Republic, India
Insect	60	96.8	62	
Tick/Spider	17	100.0	17	
Rash	70	95.9	73	Cuba, Mexico, Dominican Republic
Atopic dermatitis	19	100.0	19	
Contact dermatitis	12	100.0	12	
Drug reaction	2	66.7	3	
Photosensitivity reaction	7	100.0	7	
Unknown rash	23	100.0	23	
Urticarial	8	80.0	10	
Cutaneous larva migrans	43	100.0	43	Jamaica, Thailand, Mexico
Animal bite††	22	78.6	28	Thailand, Indonesia, Mexico,

				Costa Rica, Chile
Cutaneous leishmaniasis	16	100.0	16	Costa Rica, Mexico, Afghanistan
Marine envenomation	11	84.6	13	United States, Mexico

*Percentages are calculated by total number in the database. An ill returned traveller could present with more than one chief complaint.

†Includes infection with *Rickettsia africae*, *R. conorii*, and *R. rickettsii*.

‡Includes acute bacterial, parasitic, and viral diarrhea, as well as acute diarrhea of unspecified cause.

§Includes both intestinal and extraintestinal amoebiasis.

¶Includes lice, fleas, true bugs, mosquitoes, flies, and midges.

¨Includes erysipelas, cellulitis, furunculosis, carbuncles, skin abscess, pyoderma, ecthyma, impetigo, and superficial fungal skin infections.

††Includes bites by cats, dogs, monkeys, and other animals.

£Where only one or two countries are listed, this indicates >3-way tie for second or third place.

Table 4: Cases of malaria among 2004 ill returned travellers with a travel-related diagnosis, by purpose of travel

		Type of malaria; no. of cases							
Reason for travel	**Total cases**	***P. falciparum***	**Severe or cerebral malaria**	***P. vivax***	***P. ovale***	***Plasmodium* species unknown**	**Top three‡ countries of exposure**	**Obtained pre-travel advice**	**Received prophylaxis**
All (n = 2004)	51	30	1	12	2	6	See **Table 3**	10 (19.6)	3†
Tourism (n = 883)	3	2	0	0	0	1	Gabon, Ghana, Thailand	2 (66.7)	0
Immigration (n = 493)	6	2	0	4	0	0	India, Afghanistan, Nigeria, Gabon	N/A	N/A
Visit friends and relatives (n = 206)	21	12	0	8	0	1	India, Pakistan, Nigeria	3 (14.3)	1
Missionary, volunteer, researcher, aid (n = 212)	12	9	1	0	1	1	Haiti, Ivory Coast, Cameroon	3 (25.0)	2
Business (n = 160)	9	5	0	0	1	3	Sierra Leone	2 (22.2)	0
Other* (n = 50)	0	0	0	0	0	0	N/A	N/A	N/A

NA = not applicable, P. falciparum = Plasmodium falciparum.

*Includes students (n = 42), military personnel (n = 6) and medical tourists (n = 2).

†Includes two travellers who either missed doses of doxycycline throughout travel or ran out of doxycycline prior to the end of travel.

‡Where only one or two countries are listed, this indicates >three-way tie for second or third place.

Malaria was the top specific diagnosis for those travelling for the purpose of visiting friends and relatives and was the fifth most common diagnosis among business travellers and missionaries, researchers, volunteers and aid workers (**Table 2**). Malaria was over-represented among VFR travellers ($p<0.0001$) and business ($p=0.02$) compared to other types of travellers. Malaria was also over-represented among males ($p=0.0003$). Both cases of

malaria that were diagnosed in ill returned pediatric travellers were caused by P. falciparum and occurred in children travelling for the purpose of visiting friends and relatives (VFR). Of travellers with malaria, 20% had received pre-travel consultation, yet only three took any course of malaria prophylaxis (**Table 4**). A full quarter (N=13) of returned travellers with malaria required inpatient management, compared to only 2.8% (N=55) of those without malaria ($p<0.0001$). While Sub-Saharan Africa remains the top source region for imported malaria to Canada (33/51 cases; 64.7%), India was the top specific country of exposure (8/51 cases; 15.7%). Of business travellers with malaria, 8 of 9 (88.9%) acquired their disease in West Africa or South Sudan.

In addition to malaria, enteric fever was also over-represented among those travelling for the purpose of visiting friends and relatives ($p<0.0001$) compared to other types of travellers. Cases of enteric fever due to Salmonella enterica serotype Typhi (N=2) and Paratyphi (N=2), as well as hepatitis E virus (N=1) and hepatitis A virus (N=1) were all represented among children who were visiting friends and relatives. The proportion of ill returned travellers who had been visiting friends and relatives who required inpatient management of their travel-acquired illness (12.1%) was more than five times that of ill returned travellers who had not been visiting friends and relatives (2.4%) ($p<0.0001$). VFR travellers also had the lowest proportionate uptake of pre-travel consultation among all ill returned non-immigrant travellers ($p<0.0001$) (**Table 1**). In addition, those who were visiting friends and relatives travelled for longer periods of time compared to travellers who had not visited friends and relatives (median 36 versus 18 days; $p<0.001$).

Other emerging, life-threatening and notifiable diseases were represented among the cohort of ill returned travellers. There were nine cases of newly diagnosed or acute (febrile) HIV infection, three of which occurred in non-immigration travellers and a single case of acute hepatitis B in a tourist traveller. Hepatitis E is an emerging infection among travellers and there were six cases diagnosed in this cohort, with 4 (67%) occurring in males, three (50%) in VFR travellers and two (33%) requiring inpatient management. The age range of hepatitis E cases was 4 - 63 years. Five of six cases of hepatitis E virus were acquired in South Central or Southeast Asia. Three cases of brucellosis were diagnosed in immigrant and VFR travellers. Trip duration was known for one case and was 177 days, consistent with the long duration of exposure typically associated with travel-related brucellosis.

Cutaneous larva migrans appears to be an emerging disease among ill returned travellers, with 27 of 43 (62.8%) cases occurring in travellers returning from the Caribbean. Jamaica was the top country of exposure for cutaneous larva migrans, with 18 (42%) cases acquired on this island. Ninety-three percent of cutaneous larva migrans cases (N=40) occurred in tourist travellers on short-stay trips (median trip duration 8.5 days). Of 16 cases of cutaneous leishmaniasis, 69% were imported from Central or South America and in particular, 50% were acquired in Costa Rica.

Discussion

Analysis of surveillance data on ill returned travellers presenting to a CanTravNet site between September 2011 and September 2012 has revealed the spectrum of travel-acquired illness encountered at CanTravNet sites. These data provide an update to the largest surveillance report on illness in Canadian travellers (2009 – 2011) (6).

Potentially life-threatening illnesses can occur in ill returned travellers

Malaria remains the top specific cause of fever in ill returned travellers (9,10) and in this study, was caused by the potentially life-threatening P. falciparum in 60% of cases. Ill returned travellers with malaria were eight-times as likely to require inpatient management compared to those with alternate diagnoses. Malaria is a preventable infection, yet, of patients with malaria who clearly travelled to a risk area, only 20% sought pre-travel advice and only 6% received malaria chemoprophylaxis.

It has been previously demonstrated that travellers are more likely to be exposed to blood and body fluids while travelling than at home (11,12). We noted nine cases of acute or newly diagnosed HIV in our cohort, one third of which occurred in non-immigration travellers, as well as one case of acute hepatitis B in a tourist traveller. Hepatitis B, in particular, remains a risk to international travellers, despite being almost completely vaccine-preventable (13-15). Our data reiterate the importance of pre-travel strategies which aim to reduce the likelihood of blood and body fluid exposure while travelling (16), in addition to strategies which mitigate the risk of food- and water-borne and vector-borne diseases.

Animal bites were the tenth most common diagnosis among tourist travellers and were acquired in countries such as Thailand, Indonesia, Mexico, Costa Rica and Chile, which may not have readily available human rabies immune globulin (HRIG) or vaccine that meets minimum potency standards set forth by the World Health Organization (WHO) (17). As rabies is virtually always fatal, ensuring timely access to full post-exposure prophylaxis is essential, yet it is rarely available in rural developing world settings (17). Prevention of animal bites altogether eliminates the risk of rabies and obviates the need for access to post-exposure prophylaxis and, along with rabies pre-immunization, should therefore serve as a target for pre-travel intervention in the consultation setting.

Travellers visiting friends and relatives are at risk

VFR travellers are known to acquire specific travel-related illnesses more frequently than others, likely because these travellers tend to stay in local homes, travel for longer durations and may fail to recognize the health risks inherent to travel to their country of origin (3,4,7,8,18). Although VFR travellers comprised only 10% of this cohort, they accounted for 83% of cases of enteric fever and 41% of cases of malaria. In addition, the proportion of VFR travellers requiring inpatient management of their travel-acquired illness was five-fold higher than ill returned travellers who had not visited friends and relatives, which may simply reflect that those visiting friends and relatives are more likely to seek care for more serious illness, rather than benign etiologies, as opposed to being more likely to acquire more serious illness. Those who visited friends and relatives travelled for a longer average period of time, yet, they were least likely of all travellers to have sought pre-travel advice. The data underscores the unique characteristics of these of travellers and the urgent need to identify strategies to minimize their travel-acquired morbidity.

Emerging infections among travellers are difficult to prevent

Hepatitis E is a water-borne virus with large epidemics reported from Central America, Sub-Saharan Africa, the Middle East and Asia (19,20). In our cohort, 83% of cases were acquired from the Indian sub-continent or Southeast Asia and again, those visiting friends and relatives were the most well represented type of traveller, suggesting that, as is the case for hepatitis A and enteric fever (21), more prolonged, rural and in-home travel may be a risk factor for hepatitis E acquisition. Hepatitis E infection is a particular danger for pregnant women (20), especially in the third trimester, with associated maternal mortality as high as 25% (22). Pregnant travellers should therefore be advised of this risk when travelling to endemic countries (19) and food- and water-precautions should be emphasized.

Chikungunya fever has recently emerged in the Americas (23) and it is anticipated that Canadian physicians will increasingly encounter this disease (24). Prevention of chikungunya rests on mosquito avoidance measures, principally repellents, which are often deemed unappealing by travellers (25-28). Cutaneous larva migrans, while not life-threatening, causes considerable morbidity, lost productivity and costly medical encounters due to the severity of pruritus and lack of ready access to the only effective medications, albendazole and ivermectin, which are not currently licensed in Canada. These drugs can only be acquired in Canada through the Special Access Programme of Health Canada, which necessitates a paper or electronic application for approval and has a

processing time of at least one week for each request http://www.hc-sc.gc.ca/dhp-mps/acces/drugs-drogues/sapg3_pasg3-eng.php. Prevention of cutaneous larva migrans rests on avoidance of barefoot or bare skin exposure to sand, which is difficult to achieve in beach destinations where the causative organism is prevalent. Cutaneous leishmaniasis, an emerging vector-borne disease among travellers (29), is challenging to prevent as it requires absolute bite avoidance in destinations with typically high ambient temperatures and humidity, where the use of long clothing and repellents might be deemed inconvenient (25-28). Insecticide treated bed nets and sleeping several feet above the ground may provide some protection.

Limitations

Analysis of CanTravNet data has several limitations. This report focuses only on those ill returned travellers who presented to a CanTravNet centre, thus, conclusions may lack external validity. It must be noted that many of the top illnesses in those travelling for the purpose of immigration, including latent tuberculosis, hepatitis B and hepatitis C, would have been diagnosed through screening of at-risk individuals from endemic areas and cannot be definitively linked to travel. Travellers with illnesses with very short or very long incubation periods may have sought care in different settings and these diagnoses are difficult to definitively link to travel. Similarly, ill travellers returning from destinations perceived to be low-risk may be under-represented in the CanTravNet database. The data cannot estimate incidence rates or destination-specific numerical risks for particular diseases (7,30). Variation among sites regarding screening protocols for new immigrants and refugees may have led to over- or under-contributions of particular diagnoses from individual sites. Fifty-three percent of cases were contributed by Montreal sites, which may have introduced bias given the inter-Provincial variation in travel patterns and preferences.

Conclusions

This surveillance report aims to better inform pre- and post-travel management and to illuminate changing patterns of imported diseases. Malaria remains the top specific diagnosis among travellers visiting friends and relatives and although still mostly acquired in Sub-Saharan Africa, India was the top single source country of imported malaria in this cohort. In addition to malaria, other preventable travel-acquired illnesses such as enteric fever, influenza, hepatitis B and animal bites were common and reinforce that improved translation of knowledge into action on the part of the traveller should be prioritized. In addition, barriers to the uptake of pre-travel consultation by particular risk groups, such as VFR travellers and barriers to the use of preventive interventions, such as insect repellent and malaria chemoprophylaxis, should be assessed in the travelling Canadian population.

Conflict of interest

There are no conflicts of interest to declare.

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Summary: Assessing the public health risks of microbial contamination in recreational waters by satellite imagery

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Abstract

Background: Fecal contamination of recreational waters may lead to gastroenteritis, respiratory infections, dermatitis and ear infections. In addition to directly testing waters for contamination, the World Health Organization (WHO) recommends the assessment of environmental factors known to influence water quality as part of monitoring efforts. Measurement of these factors using satellite imagery may be helpful in Canada where monitoring over large areas or difficult to access locations is needed.

Objective: To assess the added value of using satellite imagery as part of monitoring and managing microbial risks associated with recreational waters in Canada.

Methods: Satellite images were used to calculate five environmental indices that may affect the risk of contamination of recreational waters: agricultural land, urban areas (impervious surfaces), forest and wetlands. Statistical models including these indices were then compared with the average contamination level of beaches in southern Quebec, Canada. Various satellite sensors were compared against criteria of accuracy and performance.

Outcomes: Satellite imagery classification performed well for the study area. Two of the variables were significantly associated with higher coliform levels: agricultural land and urban areas. In the context of this assessment, the Landsat-5 sensor offered the best cost-benefit ratio.

Conclusion: Satellite imagery can be used to identify environmental factors associated with a higher risk of fecal contamination of recreational waters in Canada and may supplement current monitoring and risk assessment efforts.

Introduction

Swimming and activities in natural waters can be linked to various human health risks including infectious diseases. Gastroenteritis is the most common infectious disease associated with swimming, although respiratory infections, dermatitis and ear infections have also been linked to poor water quality (1-4).

Detection of microbial indicators of fecal pollution (such as fecal coliforms in water samples) is currently the main approach for monitoring water quality. Although these measures are considered necessary, the World Health Organization (WHO) recommends also monitoring sources and environment characteristics that may influence water quality for a global assessment of such risks. In combination, these two components could provide a basis to classify beaches according to pollution risk and actual level of fecal contamination (1).

Tele-epidemiology uses spatial technologies such as satellite imagery in combination with an epidemiological approach to monitor and assess the distribution of animal and human illnesses linked to climatic and environmental variations (5). Satellite imagery can provide reliable information on land characteristics over large

territories and, as such, represents a powerful asset in the global assessment of fecal contamination of recreational waters (6). Given that Canada hosts thousands of lakes that are easily accessible by large segments of the population and are being more frequently used for recreational purposes, we aimed to assess the added value of tele-epidemiology to efficiently monitor the microbial risk of these waters in a Canadian context.

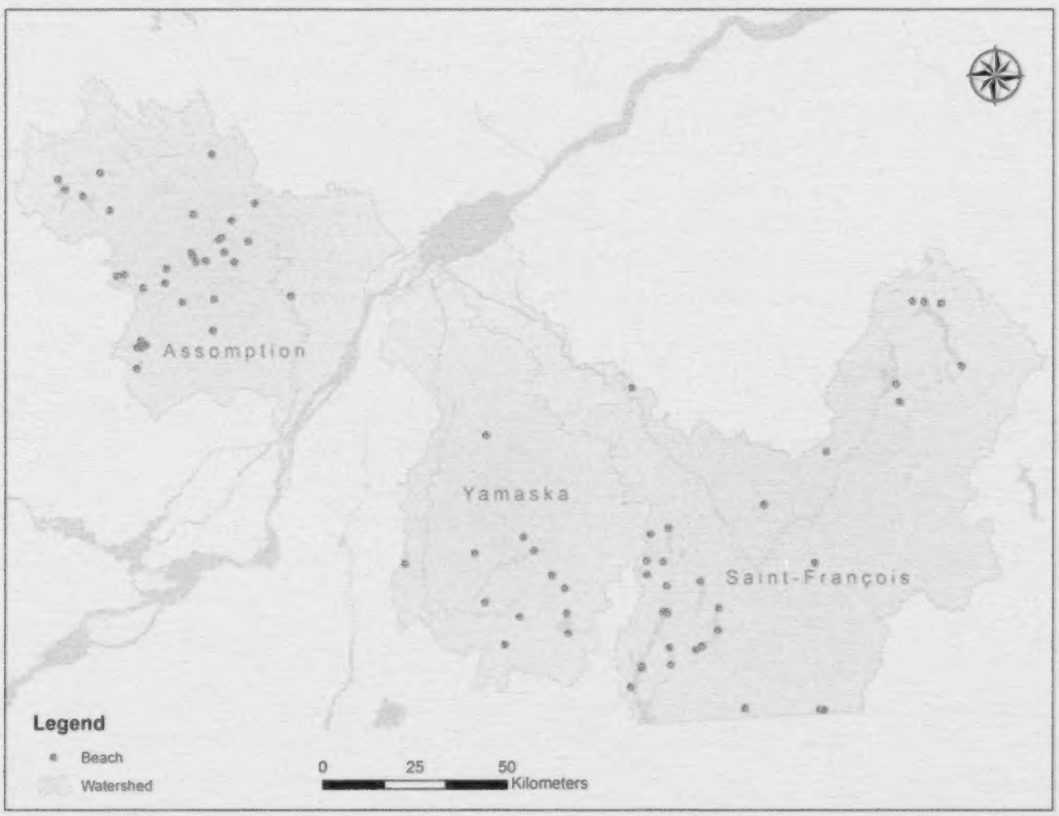
Indices derived from satellite data were included in statistical models and compared with the average contamination level of several beaches in southern Quebec. In addition to evaluating the performance of this approach, we also compared various types of satellite imagery from an operational perspective. Technical details pertaining to this study can be found in a more comprehensive report (7).

Method

Study area

The study area included three watersheds in southern Quebec, namely the Yamaska, Saint-François and l'Assomption river watersheds. Public beaches adjacent to a lake and monitored by the Quebec recreational water monitoring program for at least three summers between 2004 and 2011 were included for analysis (n=78) **(Figure 1)** (8).

Figure 1: Distribution of beaches studied on the three watersheds in southern Quebec



Measure of fecal contamination

Fecal contamination measures were taken from the Quebec recreational water monitoring program (Environnement-Plage). According to this program, water samples were taken in June, July and August every summer during the study period (from 2004 to 2011). A detailed description of this program is available (9). For this study, the geometric mean of fecal coliform concentration among all samples taken during the study period was used as an index measure representing the average contamination level for each beach. This measure was meant to represent a general contamination indicator for a given beach, with minimal influence of extreme values which may arise following specific circumstances, such as heavy rains or heat waves.

Environmental factors

Two broad types of factors are known to influence the fecal contamination of natural recreational waters and thus their quality: meteorological conditions (e.g. rainfall and temperature) which may vary depending on the time of sampling and environmental characteristics (e.g.topography and land use) which are relatively stable over time for a beach (10-14). This project addressed environmental factors associated with fecal contamination of recreational waters that remain stable over time (15).

Four factors related to the land use and land cover were extracted from satellite images (agricultural lands, impervious surfaces, forest and wetlands). Agriculture lands include cultivated areas and pastures. These lands are known to influence water quality downstream since they can be a source of fecal microorganisms from spread manure or grazing animals (16,17). Impervious surface were used as a proxy of urban areas. These areas can be linked to fecal water pollution through wastewater treatment plan discharges and urban runoff (13). Conversely, forest and wetlands have been associated with a better water quality by acting as a filter of microorganisms (18-20). Four additional factors associated with specific geohydrological characteristics of the beaches and not extracted from satellite imagery were also added to the analysis. These were: land topography, number of tributaries, the lake area and an index of plant hardiness by Environment Canada, the latter being used to represent the region's average climatic conditions (21,22).

Estimate of environmental factors by satellite image classification

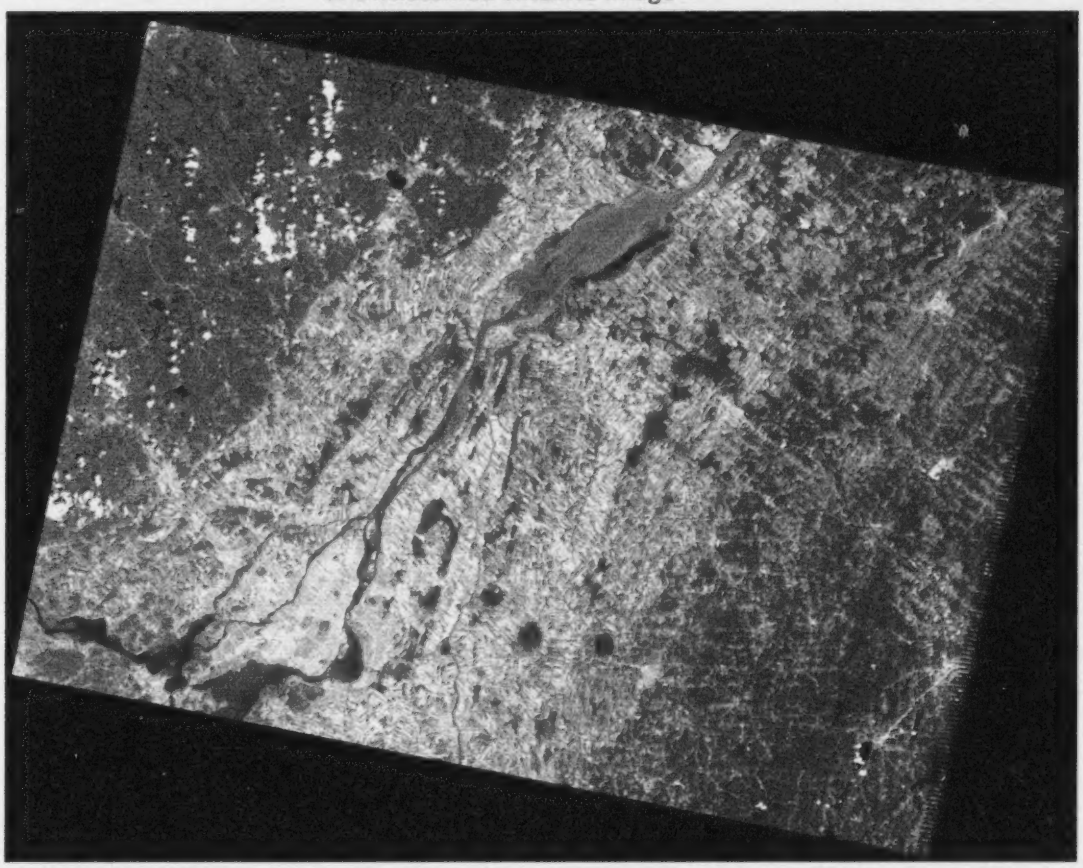
Various satellite sensors were used to extract land use data: SPOT-5, Landsat 5, Meris FRS L1, Moderate-resolution Imaging Spectroradiometer (MODIS), Advanced Very High Resolution Radiometer (AVHRR), GeoEye-1 and WorldView-2. **Figure 2** illustrates the steps involved in transforming raw satellite images into classified images that can be used for analyses. Every sensor offers specific features that can affect their capacity to assess environmental characteristics associated with a higher level of fecal contamination of recreational waters. In the context of possible use in a monitoring program, we also looked at operational criteria including the cost of images, hours of work, level of expertise and material required to process images as well as criteria relating to the fit and performance of statistical analyses representing the association between contamination levels and environmental factors.

Figure 2: Diagram of general methodology for processing various satellite imagery used in the assessment

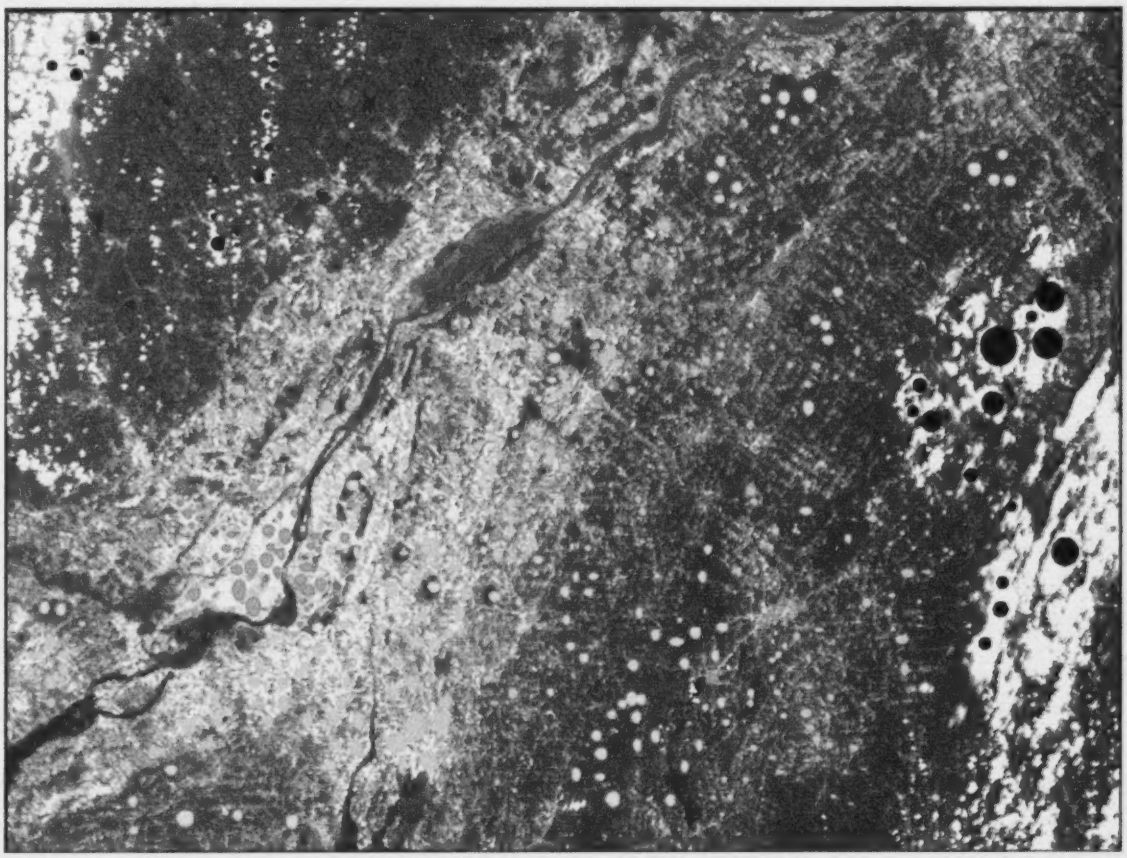
From the image acquisition, this process includes the correction and the calibration of the images and the selection of training sites for the classification of images. Classified images representing various land covers are used for data extraction and then epidemiological analyses.

Correction and calibration of the satellite image

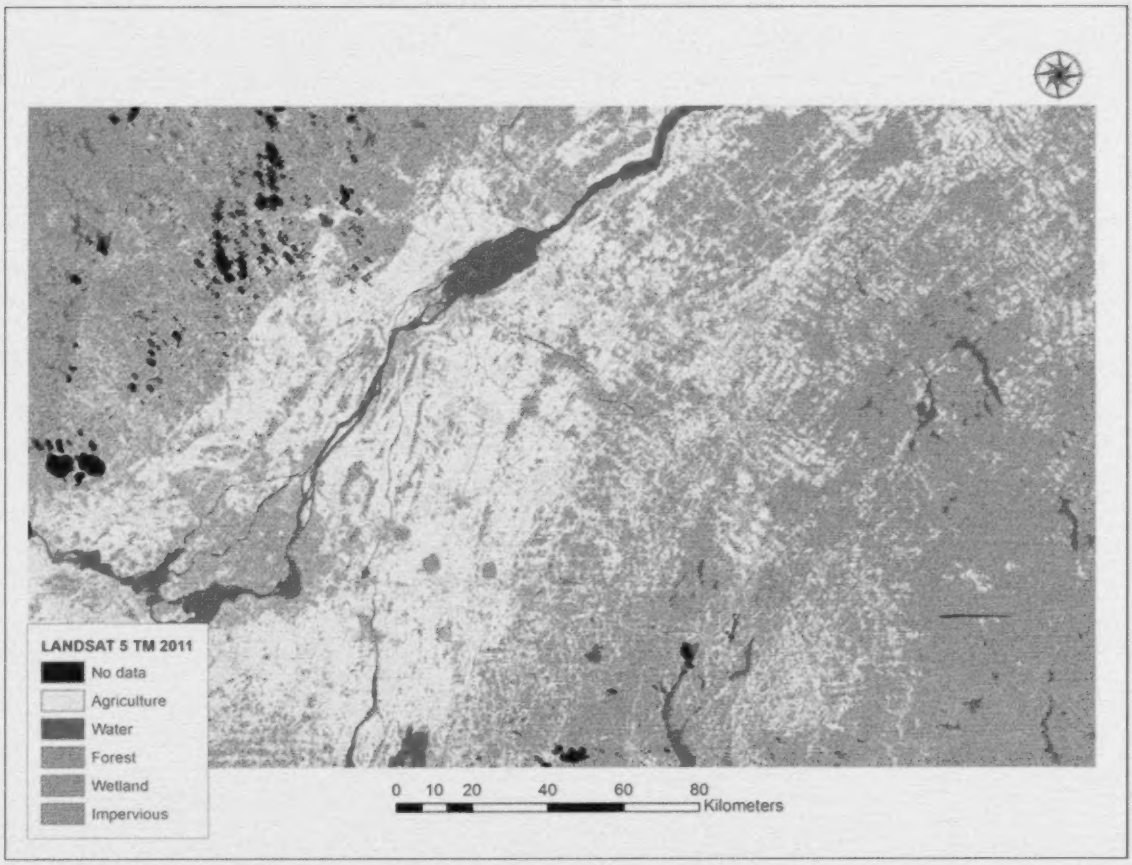
a. Unclassified satellite image



b. Sites selected for identifying and characterizing surfaces to be classified



c. Classified image



Statistical Analyses

For each sensor, we performed logistic regressions to assess the relationship between mean coliform concentration and environmental factors.

Outcomes

Performance of satellite imagery in characterizing the territory

Satellite imagery classification performed well for the study area but the estimates of surfaces corresponding to environmental determinants studied were highly influenced by the type of satellite images used.

Statistical analyses

Using logistic regression analyses, we identified two land uses associated with a greater risk of having a higher level of fecal coliforms: 1. farming activities and 2. urban activities. Among the sensors studied, Landsat-5 performed best in terms of goodness-of-fit of the model and in terms of the model capacity to classify the beaches in the right category.

Comparison of earth observation imagery

Several types of satellite imagery used in this study were compared according to the various operational criteria previously mentioned. In light of these comparisons, Landsat-5 presented the best compromise between all criteria, especially because if offered the best statistical performances and provided free images.

Discussion

This project showed that data extracted from satellite imagery can be used to characterize regional areas and identify environmental factors associated with a higher risk of fecal contamination of recreational waters. Identifying beaches with a higher risk of fecal contamination is an important component of a global assessment of water microbiological quality, integrating both risk and current level of fecal pollution. By pre-identifying high-risk locations and specifying the possible environmental susceptibility of beaches to fecal contamination, this approach could contribute to better resource allocations for risk assessment activities, especially over large territories where hundreds of beaches need to be monitored.

Other sources of data can be used in addition to satellite imagery to characterize the environment. Census, surveys and field records have been used many times and have proven their reliability. Nonetheless, in comparison, satellite imagery may provide greater benefits. Some limitations must be also taken into consideration before a broader application such as this one in recreational water monitoring programs. **Table 1** summarizes the advantages and disadvantages of using satellite imagery to detect recreational waters more at risk of fecal contamination.

Table 1: Advantages and disadvantages of using satellite imagery to detect recreational waters at risk of fecal contamination

Advantages	Disadvantages
Provides considerable coverage including hard-to-reach areas	Requires technical training to gather, process and analyze data
Reproducibility	Limited awareness within public health
Constancy	Cost for some images
Precision	Some sensors unable to capture data under cloudy conditions

This project illustrates one of the many contributions that satellite technologies can make to improve public health. Indeed, the current technical performance and operational reliability of available remote-sensing satellites make them relevant and efficient when addressing various public health issues, including vulnerable populations in remote areas, public health emergencies, health security issues (e.g. a natural disaster or an outbreak) and environmentally dependant diseases like those transmitted by insects or wildlife. Overall, space technologies are now considered to be mature and versatile solutions which can effectively enhance our current capacity to deliver key public health objectives including health surveillance, risk assessment and emergency preparedness and response.

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Conflict of interest

No conflicts of interests to declare.

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Notes from the Field: The impact of super typhoon Yolanda on the routine immunization program in the Philippines

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On November 8, 2013, the most powerful typhoon ever recorded made landfall in Guiuan, Philippines. Before dissipating on November 11, the typhoon travelled west across 41 provinces. It is estimated that 16 million people were affected (17% of the total population), with 4.1 million displaced, 6,300 people reported dead and 1,061 missing (1,2). The extensive damage to infrastructure, power and water supplies, as well as communications facilities was due to a combination of strong winds (recorded in excess of 300 km/h in some areas) and the unexpected storm surges along some coastal areas, similar to what would be experienced as the result of a tsunami (1).

Through the Global Outbreak & Alert Response Network (3), the World Health Organization (WHO) requested public health assistance from the Public Health Agency of Canada and I was one of the epidemiologists that provided support. Before I arrived, four of my colleagues from the Agency had already worked in the field for varying durations from November 2013 through to February 2014. They provided a range of guidance and support in a post-disaster response capacity in the areas of surveillance and outbreak response. When I arrived in late February 2014 (nearly four months post-disaster), the WHO Philippines had begun the shift from response to recovery, with a focus on longer term initiatives and programs.

Upon arrival, I was assigned as the WHO focal point for the Expanded Programme on Immunization in Region 8, the most heavily affected region. My primary objective was to conduct an assessment to determine how the typhoon had impacted routine immunization across the region. This was a continuation of the assessment initiated by a consultant from the U.S. Centers for Disease Control and Prevention who was in the region for a week in late February 2014. From February to April, 2014, 54 facilities in 35 municipalities were visited. The majority of facilities reported structural damage and loss of electricity due to the typhoon. As a result, a large proportion of facilities were required to interrupt their routine immunization activities. The median duration of interruption was eight weeks, but a subset of areas was without routine immunization for more than three months. However, at the time of the site visits, all facilities had managed to successfully resume their routine immunization activities.

Through this assessment, key criteria for successful immunization program recovery were identified. These included the importance of disaster-resilient cold chain equipment, well-established contingency plans for maintenance of the cold chain and clear processes for provision of immunization supplies (e.g. replacement records) and replacement vaccine stock in the event of a disaster. The results of the assessment will be used by the WHO and the Department of Health, Philippines, to resolve the challenges identified and to strengthen the routine immunization program.

My experience did include some challenges, specifically related to: understanding the complex public health system in the Philippines; developing meaningful relationships with key national/regional/provincial governmental and other non-governmental organization stakeholders in a very short time; and limitations resulting from logistics restrictions. However in spite of this, my overall impressions were very positive. I was impressed with the resiliency and professionalism of the Filipino health workers who I met through my travels across the region. Many of these people were directly affected by the typhoon and had lost family members, friends or colleagues in the disaster. Despite this, I witnessed a strong commitment to ensuring the children in their communities had access to the Expanded Programme on Immunization Vaccines.

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